Multiscale Actuation and Sensing: Overview

Bill Kaiser, Mark Hansen, Gaurav Sukhatme and the MAS Team

Controlled Mobility, Adaptive Sampling, NIMS and NAMOS

- **Controlled mobility may reduce the energy cost of data transport in wireless sensor networks**
- **Multiscale methods can exploit sparsely deployed low resolution sensors to both extract models of observed phenomena and detect events that guide actuated sensors to best sample dynamically varying fields.**
- **Development of aquatic sensing systems (NAMOS lake monitoring) and NIMS (aquatic stream, river, and lake systems as well as many terrestrial ecosystems).**

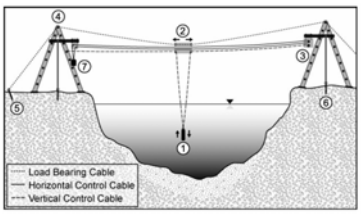


Figure 1. The NIMS RD system is shown in schematic view. The cableway system provides support for the sensor node payload (1). The cableway supports a horizontal actuator (2) controlled by an embedded computing system (3). The cableway is supported by aluminum support towers (4), and anchor systems (5), and (6), while a counterweight (7) provides tension.

Source: CENS Technical Report #60 High Resolution River Hydraulic and Water Quality Characterization Using Rapidly Deployable Networked Infomechanical Systems (NIMS RD)

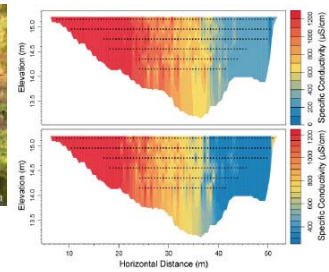
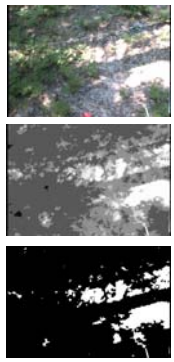


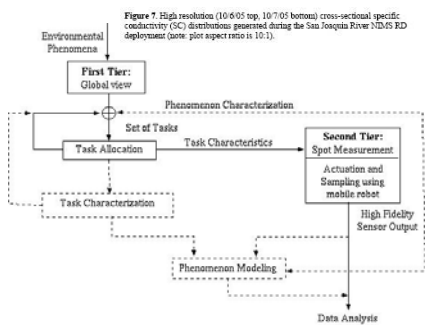
Figure 7. High resolution (10/6/05 top, 10/7/05 bottom) cross-sectional specific conductivity (SC) distributions generated during the San Joaquin River NIMS RD deployment (note: plot aspect ratio is 10:1).

NIMS: Networked Infomechanical System

- Multiscale Sensing:
  - Hierarchy of sensor data sources
  - Varying levels of resolution
  - Achieve high fidelity by multiple levels of sparse sensing
- Model Based Methods:
  - Directly extract phenomena behavior
  - Communication, computation, and actuation optimized for highest utility sensing operations
  - Continuous model update

MAS Theory





Architecture and Performance

Actuated Laser Range Sensor

Medium Characteristics, H

Belief about Phenomenon, I

Current Configuration, X

Distributed Actuation Algorithm

$dx=f(H,X,I,C)$

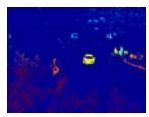
dX, small actuation command

Motion Actuators

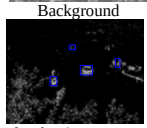
Pan, Zoom, Tilt Camera

Background

Difference

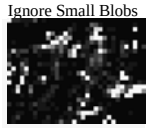


Ignore Small Blobs



Filter by Aspect ratio

Events



5000 events collected

Coordinated Actuation for Environment Observation

NAMOS: Networked Aquatic Microbial Observing System